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The effects of self-regulation smoking-delay strategies on smoking delay following moderate intensity exercise

By

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Abstract

Research has consistently shown that acute bouts of moderate intensity exercise have an important effect on smoking urge and smoking delay. The purpose of the present study was to examine whether self-regulation strategies, aiming at smoking delay, can further extend the effect of moderate intensity exercise on smoking delay. Participants were 40 adult smokers who were randomly assigned into two groups: plain exercise (E-group, control) and exercise and self-regulation (ESR-group, experimental). A repeated measures design was adopted including a neutral condition (20 min video) and an exercise condition (20min moderate exercise). The results showed that smoking delay increased significantly for both groups; however, the increase for the ESR-group was significantly larger than that of the control group. The results support previous evidence regarding the anti-smoking effects of acute exercise; furthermore, they highlight the usefulness of self-regulation strategies, and in particular goal setting, in extending smoking delay. The present findings provide important evidence for the exercise and smoking literature and useful directions for the development of smoking cessation interventions.

Contents

Smoking

Smoking is considered one of the biggest public threats globally. According to the World Health Organization (WHO, 2016), tobacco is responsible for the death of as many as half of its users. From a total of 6 million deaths each year caused from smoking, more than 5 million of them are smokers, and more than 600.000 are exposed to passive smoke (WHO, 2016). A large number of studies indicate the detrimental effects of tobacco use. These include lung cancer, chronic obstructive pulmonary disease, heart disease, and diabetes are leading causes of death (Women and Smoking: A Report of the Surgeon General, 2002). According to WHO (World Health Organization), the majority of these health disorders constitute the list of the top 10 causes of death globally in 2015. Chronic obstructive pulmonary disease leaded to 3.2 million deaths while lung cancer (along with trachea and bronchus cancers) caused 1.7 million deaths and diabetes killed 1.6 million people, up from less than 1 million in 2000 (WHO, 2016). More than 80% of lung cancer deaths are attributed to smoking, and approximately one-third of all cancer deaths are attributed to tobacco use (Warren, 2016). Nevertheless, smoking can harm other vital organs as well. The 2014 Surgeon General's Report (SGR) identifies additional types of cancers that are linked to smoking: cancer of the colon and of the rectum (also called colorectal cancer) and liver cancer (Warren, 2014).

Despite the harmful effects of tobacco use, in 2015, more than 1.1 billion individuals, aged 15 years and older smoked globally, and the smoking rates appear to be increasing in the Eastern Mediterranean and African region, according to the Global Health Observatory (WHO, 2016). The percentage of Greek adolescent smokers, are among the highest in Europe. In

particular, Sichletidis, et al., (2009) found that the prevalence of smoking among high school students in Greece was higher than that of other developed countries. Furthermore, youth who smoke exercise less than those who abstain, maintain an unhealthy weight and they seem more prone to other healthy risky behaviors, such as alcohol consumption and drug use (Willard, Schoenborn, & National Center for Health Statistics,1995; Neumark-Sztainer, Story, Dixon, B & Murray, 1998).

Taking that into perspective, people, curiously, continue to smoke despite their being relatively aware of tobacco's mortality rates. Several studies indicate that the most dominant motives for smoking are psychosocial in nature (Piko, Varga &Wills, 2015); in addition, other common factors are smoking for pleasure, stimulation smoking, and automatic smoking, which may be explained by neurochemical theories of dependence (Ho, 1989; Lujic, Reuter, & Netter, 2005; Bidwell, McGeary, Gray, Palmer, Knopik, & MacKillop, 2015). Neurobiological motives lead to smoking addiction and dependence. Theodorakis (2010) stressed that through smoking, chemical substances (beta-endorphins, serotonins) are released in the circulatory system, causing emotions of euphoria and relaxation, making smokers more and more addicted, as through the smoking procedure, they feel able to cope with bad mood and depression

Concerning the psychosocial motives, several studies attribute smoking initiation to social factors, such as friends and family. Mushtaq and Butt (2016) indicate the association between smoking and social, psychological and demographic factors. Hassandra (2012) has shown that when parents are smokers or being receptive to smoking, the likelihood of their children starting smoking is higher. In a recent study, Sylvestre (2017) stressed that smoking initiation in childhood is affected by children's social environment. Singleton and Pope (2000), suggested that smoking for adolescents and adults is linked with the satisfaction of emotional

needs. Finally, Theodorakis, Papaioannou, Hatzigeorgiadis, and Papadimitriou (2005) found that a relatively large percentage of pupils living with one parent are smokers and non-exercisers, and a relatively small percentage of these students are frequent exercisers.

Physical Activity

Physical activity is defined as any body's movement produced by skeletal muscles that results in energy consumption (Westerterp, 2008). Growing evidence provides support for the significant and plentiful benefits of physical activity. A physically active lifestyle reduces mortality, increases life's expectancy and improves quality of life (DeRuiter & Faulkner, 2006; Paffenbarger, Hyde, Wing, & Hsieh, 1986; Lee et al., 2012). Individuals who exercise report a decrease in anxiety, depression, anger, and an increase in enjoyment (Wilson, Morley & Bird. 1980; Motl, Berger, & Leuschen, 2000; Bartholomew, Ciccolo, 2005) Furthermore, physical activity helps people reduce the intensity of their daily lives and relax, and acts as an effective stress reduction strategy (Theodorakis, 2010).

Being physically active, forestalls many chronic diseases as hypertension, diabetes, stroke and cancer (Renehan, & Howell, 2005) Physical activity may promote mental health and psychosocial function (Bakhshalipour, 2016; Zhu,2014; McKinney et.al., 2016). Individuals who engage in regular physical activity are more likely to have higher self-esteem, optimism and happiness than those who follow a physically inactive lifestyle (Cekin, 2015). The terms physical exercise and physical activity are often used interchangeably. However, exercise is a structured form of physical activity that aims in maintaining and improving physical health and often, it is conducted under supervision (DeRuiter & Faulkner, 2006). Likewise, exercise has been shown to improve physical health (e.g. metabolic syndrome) and quality of life (Fitzsimons, 2017), perceived body image (Vurgun, 2015; Fountoulakis, & Grogan, 2014), depressive symptoms and

individual's coping strategies with stress and relief for anxiety disorders (Gallaway & Hongu, 2016; Gerber, et al., 2014; Theodorakis, 2010; Blumenthal, 2012; Smith & Blumenthal, 2013).

A large amount of studies continues to support a growing literature, suggesting that exercise and physical activity interventions have beneficial effects across several physical and mental-health outcomes. Generally, participants engaging in regular physical activity display more desirable health outcomes across a variety of physical and mental conditions (Penedo & Dahn, 2005)

Exercise and Smoking

Despite the detrimental effects of smoking on health, tobacco consumption rates remain high. According to Eurobarometer on Europeans' attitudes towards tobacco survey, the highest rates of smokers (38%) are seen in Greece. Considering that exercise has been recognized as one of the most vital and natural approaches to prevent and treat health issues and addictive behaviors, as heart diseases, smoking, obesity, alcoholism (Khan et al., 2012; Dean et al., 2015), whereas smoking is one of the major unhealthy habits, various types of physical activity intervention programs have been developed in order to assist smoking cessation (Patten et al., 2003; Ussher et al., 2014; Abrantes et al., 2014). Gallaway, and Hongu, (2016), recommend the integration of physical activity in community based programs, as it has been found that motivates individuals to retain a healthier lifestyle, after the end of a program. Similarly, Nieman, (2003), pointed that exercise is an essential component in smoking cessation programs. De Ruiter and Faulkner, (2006), suggest physical activity as a non-pharmaceutical, harm reduction strategy. Similarly, Theodorakis et al. (2005), indicates that exercise may prevent people from smoking,

and even assist smokers' efforts quitting. On the other hand, Ussher et al., (2000, 2005) did not find enough evidence about the relationship between exercise and smoking cessation.

It is well known that systematic smoking causes a strong addiction that can hardly be eliminated. Regarding quitting attempts, Hughes et al. (2004) found that 70% of current smokers are willing to quit, but only a 3-5% managed a 6-12 months prolonged abstinence. Similarly, Bolliger (2000), indicated that although the majority of smokers are interested in cessation, that are unable to cope with the cigarette cravings. The main cause of relapse in smokers attempting to quit is the inability to resist urges to smoke. Studies have been shown that smoking urge appears to have a longer delay following exercise and recommend exercise as a way to reduce smoking cravings (Taylor, 2007; Elibero, 2011; Janse Van Rensburg, 2013; Nair, 2013; Kurti, 2014; Zourbanos 2016; Hatzigeorgiadis, 2016).

A variety of intervention programs aiming to smoking cessation revealed mixed results. Marcus et. al, (1999; 2005) provided supportive evidence for the beneficial effects of exercise on smoking cessation in the long term. Although, there is a lack of strong evidence that physical activity and smoking are inversely related, further investigation of the features and characteristics of programs which address exercise, as a complementary strategy for smoking cessation, is needed.

A promising feature of some smoking cessation programs, is the use of self- regulation strategies. Self-regulation, is a process, during which individuals assume the responsibility of learning, by self-monitoring their progress and using strategies that will lead to self-improvement and personal goals (Zimmerman, 2000). According to Murphy and Tammen (1998), self-regulation strategies assist individuals to maintain and improve their mental and

physical well-being. Types of psychological self-regulation strategies are, among others, goal setting, self-talk and breathing techniques, which have been used in the physical activity realm to enhance performance, facilitate learning and regulate behavior. In addition, consultation and use of psychological strategies have been used in several smoking cessation programs to help smokers cope with smoking issues (Ussher, 2005). In particular, goal setting is a common psychological strategy, which have been applied in organizational and sport psychology for stimulating motivation (Locke & Latham, 1985). Self-talk can be described as what people say to themselves, either silently or loudly, inherently or strategically, in order to stimulate, direct, redefine and evaluate their events and actions (Hatzigeorgiadis, Zourbanos, Latinjak, & Theodorakis, 2014). Concerning breathing techniques, research has been shown that conscious breathing, that is, paying attention to breathing and learning how to handle it, is one of the most effective ways to reduce daily stress and improve various health factors, such as mood and metabolism (Tzatzaki, 2015). Summing up all the above, it could be stated that the potential use of self-regulation strategies, may assist smokers reduce or even quit smoking and at the same time, adopt a healthy exercise behavior. Thus, the purpose of this study is to investigate whether the use of self-regulation strategies, in combination with aerobic exercise, could have an effect on smoking behavior.

Literature Review

Exercise and Smoking

Smoking and physical activity are two behaviors of major interest to public health. Growing evidence provides support for the benefits of regular exercise for health, irrespective of age, nationality and social class (Haskell et al., 2007; Pate et al., 2006). Theodorakis, Yoti and Zourbanos (2005) pointed out that plain physical activity by its own right, or in combination with behavioral support and counseling, has proved as a key factor on smoking cessation. Furthermore, evidence suggests that physically active individuals tend to smoke less than physically inactive (Theodorakis & Hassandara, 2005; Thorlindsson, Vilhalmsson, & Valgeirsson, 1990) and have less possibilities of becoming smokers than those who follow an inactive lifestyle (McGovern, Rodriguez, & Moss, 2003).

Regarding smoking, evidence suggests that this harmful habit worsens and increases various functional problems and leads to serious illnesses. Although cigarette smoke contains many chemicals classified by the International Cancer Research Organization (IARC) as directly related to cancer ("A" carcinogens), cigarettes continue to be sold as a legitimate product. Hughes et. al (2004), pointed that smoking cessation attempts, without professional support have a rate success 3 to 5%. Various methods have been tested in order to assist smokers quit smoking. Pharmacological therapies (bupropion or varenicline), nicotine substitute, and efforts combined with behavioral counseling show low success rates (Cahill, Stead, Lancaster, & Polonio, 2012; Cahill, Stevens, Perera, & Lancaster, 2013; Hughes, Stead, Hartmann-Boyce, Cahill, & Lancaster, 2014). Recently, electronic cigarette has been proposed as a smoking

cessation method, however, it needs to be studied adequately, as scientific opinions are inconclusive (Rahman et al, 2015).

Therapists in their effort to find effective strategies to help smokers reduce or even stop smoking recommend exercise as an alternative form of treatment (Ussher, Taylor, & Faulkner, 2014). In particular, McDermott, Dobson and Owen (2009), stressed that, moderate to high level, physical activity, may contribute to abstinence from smoking, and assist former smokers to overcome smoking relapse. Over the last decade, surveys and reviews which provide support for the hypothesis that there is an inverse relationship between exercise and smoking are constantly increasing.

Cross-sectional studies

Cross-sectional studies have shown an inverse relationship between exercise and smoking for adults and adolescents. Studies concerning adolescents indicated that the frequency of exercise during their leisure time, was inversely proportional to smoking (Marti, & Vartiainen, 1989; Thorlindsson, Vilhalmsson, & Valgeirsson ,1990; Coulson, & Eiser, 1997). Theodorakis and Hassandra (2005) examined differences between exercisers and non-exercisers in smoking behavior and concluded that the more years they spent exercising the less they smoked, and also that active athletes and former gymnasts smoked less compared to those who had never been involved in exercise. Concerning adults, Conway and Cronan (1992), who surveyed 3045 people with an average age of 28.2 years found that those who smoked participated in fewer exercise sessions per week and were practicing for a shorter period of time. In a more recent study, Papathanasiou et al. (2012) in their study with Greek students, found that non-smokers were significantly more active than smokers, and the smoking habit, reduced the possibilities of

participation in moderate and high intensity physical activity. In recent years, more and more studies focus on the investigation of the relationship between physical activity and nicotine dependence. For instance, Atalay, Taspinar, Taspinar, and Cavlak (2014) found that the group which was highly dependent on nicotine showed the lowest levels of physical activity and the highest scores in sedentary life. Also, Laaksonen, Luoto, Helakorpiand and Uutela (2002) examined whether changes in smoking behavior related to changes in physical activity. The results indicated that smoking cessation was associated with increases in physical activity levels. Finally, a more recent study of Leatherdale, Wong, Manske, and Colditz (2008), investigated how physical activity in youth is associated with susceptibility to smoking among never smokers. For the 14.795 students who had never smoked, smoking susceptibility was negatively associated with being highly active. Summing up, the literature provides supports for the hypothesis that physical activity is related with lower smoking rates.

Intervention studies

According to researches, smoking cessation programs would benefit from the inclusion of strategies that promote physical activity as a preventive method for smoking (Audrain-McGovern, et al., 2003). Intervention studies are fewer than those examining acute effects, although in recent years they have been significantly increased. A very recent review by Ussher and his associates (2014) about smoking cessation interventions revealed mixed results. Marcus, Albrecht, Niaura, Abrams, and Thompson (1991) examined the effects of exercise on smoking relapse. Participants were female smokers who were divided in two groups. One group applied a smoking cessation program that included behavioral support only, while the other group combined the same program plus exercise on a cycle ergometer. The results showed that there

was a significant difference in the abstaining rate at the end of the intervention in favor of the exercise group.

One of the most promising intervention was implemented by Marcus et al., (1999), who compared vigorous exercise three times a week for 12 weeks to equal contact time in within health education lectures. People in the exercise group had significantly higher abstinence levels compared to the control group. The results were sustainable after 12 months. This led the authors to conclude that vigorous exercise combined with cognitive-behavioral support facilitates smoking cessation. In addition, there was a significant body weight loss for those who participated in the exercise program and continued to abstain at the end of the intervention.

Some years later, Marcus et al., (2005), applied an 8-week program, which was a shortened version of the 12-week intervention (Marcus et al., 1999), except that it tested the effectiveness of moderate exercise intensity in smoking cessation. Results were clearly in line with the previous one. In all, the studies by Marcus and colleagues showed that exercise combined with supervision can significantly contribute to smoking cessation. Martin, Kalfas and Patten (1997) compared exercise to a control group, and combined behavioral counseling along with nicotine replacement treatment. Exercisers had better results in a less than 6-weeks intervention program; in contrast no significant results were found concerning nicotine replacement treatment. According to Ussher, Taylor, West, and McEwen, (2000), two of the studies provided support for the hypothesis that exercise intervention programs affect smoking abstinence (Marcus et al., 1999; Martin, Kalfas, & Patten, 1997). Also, Marcus and colleagues (1999) presented positive results after a year follow-up.

Smoking cessation interventions' results, confirmed the hypothesis that exercise is a predictor for smoking cessation. Prapavessis et al., (2007) examined the effects of supervised and intense exercise intensity combined to nicotine replacement therapy on smoking cessation and found that nicotine replacement treatment has better effects than exercise on its own. Ciccolo et al., (2011) implemented a 12-week intervention program. The findings did not show a significant effect of exercise on smoking abstinence. Other studies showed an emerging relationship between greater participation in exercise and higher odds for smoking cessation (Abrantes et al., 2014; Whiteley et al., 2012; Kinnunen et al., 2008).

Nevertheless, a part of intervention programs conducted over the years, did not provide rigorous evidence that exercise aids in smoking cessation (Ussher et al., 2003; Bize et al., 2010). Russell, Epstein, Johnson, Block, and Blair (1988) assigned their subjects into three groups: a) control, b) a smoking information program, and c) an exercise program that included one supervised and two unattended sessions per week. There were no differences in abstinence rates in the three groups 3 and 6 months after the intervention. In addition, participants in the exercise program did not show improvement in physiological parameters, indicating that attachment to the exercise was less than recommended. In the same light, Taylor, Houston Miller, Haskell and Debusk (1988), tested the effect of exercise on smoking cessation without, however, applying any officially proven smoking cessation program. Participants were recovering from acute myocardial infraction. It is important to be noted, that the intervention was not intended to assist smokers quit from smoking, but rather maintain smoking abstinence among smokers who were recovering after acute myocardial infraction. Results indicated that patients who were exercising, were smoking less cigarettes than those who were following a sedentary lifestyle. Summing up,

it could be stated that it is not clear yet if an intervention program including only exercise is enough to achieve long term abstinence. Additional components, such as cognitive behavioral strategies have been proved beneficial for smoking abstinence a year later (Marcus et al., 1999). Furthermore, Fox (1998) indicated that the effects of exercise in long intervention programs, should be examined in combination with changes in self- efficacy, self-confidence and self-esteem. Hassandra et al., (2013) evaluated the implementation of a 10-week smoking cessation program to promote physical activity as a supplementary strategy for quit smoking in anti-smoking clinics. The purpose of the program was first to provide psychological support and, secondly, to motivate participants to increase levels of physical activity. The promotion of physical activity was incorporated into the counseling program and was based on the principles of goal setting theory (Locke & Latham, 1990). Qualitative analyses have shown that, participants considered physical activity as a valuable additional aid for quitting smoking in the counseling program. Regarding physical activity, the results showed that participants who increased physical activity had better abstinence rates after 1 year. Recently, Tzatzaki and colleagues (2015), implemented an exercise-initiation and smoking- cessation intervention, combining self- regulation strategies. A total of 25 heavy smokers and non-exercisers participated, 9 in the control group and 16 in the intervention group. Upon completion of the intervention, 10 participants quitted smoking, whereas 6, reduced to 25% the amount of cigarettes who were smoking at baseline. The frequency of exercise, exercise self-efficacy and self-efficacy were negatively correlated to smoking behavior.

From the literature review, it can be concluded that over the last few years, many researches have examined the exercise effects on smoking cessation. The findings of these investigations have contributed significantly to not only understanding this relationship, but also

on how exercise can be used as a strategy to combat smoking behavior. However, intervention programs aimed at long-term cessation of smoking and having achieved significant results in this direction are limited. The main reason for the inability of most of them to show significant reduction or cessation of smoking was the low attachment of participants to the exercise program. It is therefore necessary to further examine the relationship between exercise and smoking cessation in order to improve the methodology of these interventions and, consequently, their effectiveness. It appears that an important and primary role in this effort should be the motivation of participants to adopt and adhere to the recommended physical activity program in order to develop the greatest possible benefits and lead to a long-term abstinence from smoking.

Experimental studies

Several researches have examined the effects of exercise on smoking related variables, divided into two groups: implementation of intervention programs referring to long term effects, and experimental studies, referring to acute effects. The literature of acute effects will be presented below. Published reviews have focus their interest on the acute effects of exercise on smoking variables (Haasova et al., 2012; Roberts et al., 2012; Taylor et al., 2007). Particularly, Taylor and his colleagues (2007) studied the acute effects of exercise on smoking urge, withdrawal symptoms, mood and emotion and the smoking behavior. In studies, which examined the smoking urge, withdrawal symptoms and negative emotions decreased rapidly during exercise and remained reduced, up to 50 minutes after exercise. Nine out of ten studies comparing the effects of an exercise session with a passive state of cigarette craving reported a significant decrease during exercise and after the session. (Bock et al., 1999; Daniel, Cropley, & Fife-Schaw, 2006; Daniel, Cropley, Ussher, & West, 2004; Katomeri & Taylor, 2006a; 2006b; Taylor & Katomeri, 2007; Taylor, Katomeri & Ussher, 2005, 2006; Thayer et al., 1993; Ussher,

et al., 2006; Ussher, Nunziata, Cropley, & West, 2001). Seven of the studies, which evaluated the smoking urge after physical activity, presented a relevant reduction within 10 minutes after the exercise session. Within those studies, the most momentous results were found in Taylor's and colleagues' (2007) research. Participants exercised for 15-20 minutes (intense walking), and they were found to abstain from smoking up to 20 minutes after exercise. Similarly, Ussher et al., (2001) examined the effects of moderate intensity cycling (stationery cycle) on smoking desire. Results confirmed previous research findings, as exercise group scored lower on smoking desire. Similarly, more recent studies (Harper, 2011, study 1, 2; Williams, Dunsiger, et al., 2011; Arbour-Nicitopoulos, Faulkner, Hsin, & Selby, 2011) were in line with the previous ones, considering that withdrawal symptoms and negative emotions decreased after low and moderate intensity exercise, but increased during high intensity.

Researchers have also examined exercising in different intensities. Daniel and colleagues (2004) tested 2 types of exercise intensity, 5 minutes of light intensity exercise versus 5 minutes of a short bout of moderate. Statistically significant differences were found showing that cycling at 40-60% of the HRR reduced the desire for cigarette compared to cycling at 10-20% HRR. Thus, 5 minutes of moderate intensity exercise had a greater effect on smoking desire. However, 10 minutes rather than 5 minutes of moderate intensity exercise were found to be more effective. Pomerleau et al. (1987) and Everson, Daley, and Ussher (2006) reported no significant differences in the smoking urge between 80% and 30% of VO2max (30 minutes); Between 55% versus 44% of the maximum heart rate (for 10 minutes), respectively. The absence of significant differences in the smoking urge between the two exercise intensities in the Everson study seems to be attributed to relatively similar exercise intensities. One of the major drawbacks of Pomerleau's research was the small number of participants (10 people). In addition, participants

were absent from smoking a cigarette for 30 minutes before exercise, which may have contributed to the reduced desire during the initial measurement, so the effects of the exercise did not become apparent. Though, there was a tendency for lower desire in terms of high exercise intensity. Taylor, Katomeri and Ussher (2005), piloted a research based on the principles of self-determination theory. Participants walked for one mile having the option to choose the preferred intensity. Results indicated a reduced smoking desire with low intensity 20 minutes' walk leading up to 20 minutes' cigarette delay. Likewise, Oh and Taylor (2014) examined whether different exercise intensities (moderate, intense and control condition) could reduce the desire for smoking, as well as biased attention to smoking related videos. The desire for cigarettes was lower after moderate and intense exercise compared to the control condition. Also, both tensions have reduced the ability of images to attract attention. Of course, only intense exercise seemed to be able to keep the look and the interest away from being swept away by cigarette images. This may advocate that choice in exercise intensity could be a factor on smoking delay. However, it should be further investigated.

Furthermore, Bock et al., (1999); Taylor et al., (2006); Thayer et al., (1993) examined the mood and emotion variable, and concluded that exercise had a positive effect on mood and emotions during smoking abstinence. In detail, Bock and colleagues (1999) reported a reduction in negative emotion, but no effect on positive emotion. The two other studies reported that exercise increased the activation and action (Taylor et al., 2006; Thayer et al., 1993). Finally, Taylor et al (2006), advocated that reduced smoking cravings can be due to the reduction of stress.

Moreover, Taylor and colleagues (2007) examined time to impulsive smoking after exercise. Time until smoking ranged from 8 to 57 minutes after exercise (Katomeri & Taylor,

2006b; Taylor & Katomeri, 2007; Thayer et al., 1993; Reeser, 1983). The exercise increased the time to the first cigarette by 8, 57, 35, and 24 minutes respectively. In particular, Reeser (1983) compared the acute effect of an aerobic intense exercise condition, a non-aerobic exercise condition consisted of minimal stretching exercises and a control condition. According to these results, only non-aerobic exercise affected significantly the delay of smoking for the first two cigarettes after exercise. In the study of Thayer (1993), smokers were asked to randomly perform either five minutes of intense walking or to remain sedentary. In the exercise condition, time until smoking prolonged significantly compared to the sedentary condition. In the same light, the other two studies' results provided support for the hypothesis that 15 minutes of vigorous exercise prolongs the time until smoking (Katomeri & Taylor, 2006b; Taylor & Katomeri, 2007). Haasova and colleagues (2012) reviewed and established the positive effects of physical activity on smoking behavior. Results were in the same direction, as physical activity groups scored higher in smoking craving reduction than the control ones, providing support for the hypothesis that physical activity reduces smoking cravings. Roberts and colleagues (2012), came up with similar results. Authors pointed out that exercise reduces cigarette cravings. However, withdrawal symptoms and negative emotions have been increased during high intensity exercise. Overall, it remains unknown which type of exercise is the most effective in reducing smoking cravings, and which type of mechanisms are associated with the effects.

However, apart from the above reviews, there are more recently published studies which examined the acute effects of exercise on smoking variables. Janse Van Rensburg, Elibero, Kilpatrick, and Drobes (2013) found that both low-intensity and high-intensity exercise significantly reduced the smoking cravings and increased positive emotions compared to the control condition. The effect of low to moderate intensity exercise were examined by Prapavessis

and colleagues (year who found a significantly reduced urge to smoke in the exercise condition compared to control. Exercise condition favored in terms of withdrawal symptoms as well. A self-selected form of physical activity was tested by Zourbanos and colleagues (2016). Smokers were asked to choose the type of exercise intensity. Results demonstrated that smokers presented an enhanced preference for "self-selected" forms of physical activity. This study indicated that smoking cessation and motivation for physical activity may be increased by giving smokers the choice to select the intensity of physical activity programs.

Also, Hatzigeorgiadis and colleagues (2016) tested the acute effects of moderate intensity exercise in combination with self-regulation strategies on smoking delay. Participants were 11 physically inactive smokers who attended 3 experimental conditions (control, exercise, and exercise using self-regulation strategies). Results were in line with previous research supporting the hypothesis that acute exercise reduces smoking cravings. Furthermore, authors suggested that the use of self-regulation strategies may enhance exercise performance.

Summing up the literature findings, most of the studies which examined the acute effects of exercise on smoking variables, suggest that physical activity has a positive effect on smoking cravings and withdrawal symptoms. However, there are minor differences in the magnitude of this effect for low, moderate and high exercise intensity. Furthermore, acute effects of exercise should be developed and integrated in smoking cessation programs.

Self- regulation

According to Zimmerman (2000), self-regulation is a process in which individuals undertake responsibility for learning by self-monitoring their progress and using strategies that will lead to self-improvement and personal goals. Through cognitive control mechanisms the

implementation of self-regulation strategies may result in the development of thought, emotions and behaviors (Karoly, 1993). People with greater self-regulation ability are committed to healthier behaviors and are more successful in becoming more physically active (de Bruin et al., 2012). Bandura (1997), pointed that intervention programs which enhance self- regulatory abilities, drive people's beliefs about their physical abilities. Self-regulation has been associated with physical activity in adolescents and adults (Dishman et al., 2005, Hallam & Petosa, 2004, Petosa, 1994, Resnicow et al., 2003, Umstattd, Saunders, Wilcox, Valois, & Dowda, 2006), and self-regulation strategies have been integrated into many physical activity interventions with elderly participants (Harada, Chiu, King, & Stewart, 2001; Pinto, Lynn, Marcus, DePue, & Goldstein, 2001; Stewart et al., 1997). Self- regulation strategies which are going to be applied in this research include goal setting, self- talk and breathing techniques.

Goal Setting

Goal setting is a common psychological technique, which is widely used in organizational and athletic psychology for stimulating motivation (Locke & Latham, 1985). Goal setting enhances individuals in performing better a specific task by directing attention and regulating the amount of effort required, and also by setting up a strategic plan to achieve the desired goals. Goal setting works as a motivational strategy which requires commitment, determination, concentration and development of strategies towards goal accomplishment (Locke & Latham, 1985; 1990). Goal setting has been found to have a positive effect in sport setting, as it helps athletes enhance their performance by regulating their actions (Browne, & Mahoney, 1984). Kyllo and Landers, (1995), found that long term or short term goals affect performance when they appear realistic and specific. That is, based on Bandura's theory (1977), goals should be set in order to indorse self- efficacy.

Self-talk

The things we say to ourselves are able to influence dramatically what we do, and how we feel and regulate our future actions. According to Zinsser, Bunker, and Williams (2010), self-talk is the key factor to establish cognitive control. Self-talk is described as what people say to themselves, either silently or loudly, inherently or strategically, in order to stimulate, direct, redefine and evaluate their events and actions (Hatzigeorgiadis, Zourbanos, Latinjak, & Theodorakis, 2014). Any person who has been engaged in some form of exercise may have committed to self-talk at some point in time (Gibson & Foster, 2007). Self- talk could be distinguished into instructional and motivational. Instructional self-talk comprises statements regarding focus and concentration, technical information and strategic choices, whereas motivational self-talk regards statements related to confidence development, positive moods and effort contribution (Zinsser, Bunker, & Williams, 2001). Self- talk is a mental strategy, which has been widely used in sport settings, and may enhance performance, increase athletes' concentration, self-confidence and self- esteem while reduces anxiety (Theodorakis, Hatzigeorgiadis, & Zourbanos, 2012). However, Vygotski (1962) indicated that it could be used as a self- regulatory strategy in all aspects of behavior. Thus, it has been widely examined in other fields, for instance physical activity, or children with learning disabilities. Results confirmed that self-talk could replace negative thoughts, since it works as a self- regulatory strategy and increases performance (Theodorakis, Hatzigeorgiadis, & Zourbanos, 2012; Zourbanos, 2013). Summing up, Hatzigeorgiadis, Zourbanos, Galanis and Theodorakis (2011) in their meta- analysis, examined 32 surveys on self-talk interventions, and confirmed that self- talk is an effective strategy to enhance performance in sport. This study emphasized that in order to

increase self-motivation, should be given attention in choosing the right type and content of self-talk, in combination with the characteristics of the sport and the needs of each individual.

Breathing

Breathing is a survival function. Willingly controlling breathing can be used as a treatment or self-regulation strategy, since it is possible to bring modifications in the autonomic reactions; it has been used in relaxation techniques or part of multidimensional mental training for athletes (Vealey, 2007). Additionally, breathing has been used as a strategy for coping with addictive substances as part of a whole section in order to reduce craving, withdrawal symptoms, anxiety, depression and stress (Chen et al., 2010). Slow breathing is assumed to decrease blood pressure (Rosenthal et al., 2001) and lead to a better oxygenation (Bernardi et al., 2001). Furthermore, Chandla and colleagues (2013) examined the effect of breathing exercises during a 6- week intervention program. Upon completion of the intervention, results showed a significant decrease on participants' anxiety levels, and an overall improvement in their quality of life. Many studies also demonstrate the usefulness of breathing in reducing the smoking desire and withdrawal symptoms. McClernon, Westman, and Rose (2004) found that controlled deep breathing significantly reduced withdrawal symptoms including cigarette craving and negative emotion (irritability), while maintaining excitation levels (concentration). In two studies, the participants followed an acoustic guide that invited to concentrate on breathing by focusing on the abdominal area. This approach led to an acute reduction in the desire for cigarette and withdrawal symptoms (Cropley, Ussher, & Charitou, 2007, Ussher et al., 2009).

Collectively, self-regulation strategies have been proven beneficial not only in the sport domain but also for behaviour change. They may have a positive effect on smoking abstinence.

There are a few studies which provided support for the hypothesis that goal setting, self- talk and breathing could aid on smoking abstinence in conjunction with exercise. Ushher and colleagues (2005, 2008) specified that goal setting combined with counseling in long-term intervention does affect smoking cravings. Gilbert (2009) was the one who suggested self-talk as a strategy for smoking reducing into self-compassion intervention. Nevertheless, few studies about breathing and smoking have shown some promising results (Dai, & Sharma, 2014; Mehta, & Sharma, 2010; Sharma, Gupta, & Bijlani, 2008). Through the use of self-regulatory strategies, we can move from theory to the practical application of these basic principles. Goal setting enhances the satisfaction of the need for competence as the stakeholders achieve small, short-term, measurable goals and increase their loyalty to themselves. Also, in relation to the need for autonomy, when people set goals reflecting their personal choices, they are more actively involved in achieving them as they feel more responsible for their choice. Motivating and facilitating the individual to receive pleasure and satisfaction from engaging in behavior, may result in increases in autonomous forms of motivation which enhances perseverance and long-term commitment to desired behavior. Breathing exercises also create a sense of calm, remove the irrelevant and negative thoughts and help to increase the concentration in the process that takes place and thereby strengthen the self-control of the individual. In this way the individual is aware and control of the whole process, which also increases the satisfaction of the need for autonomy. In addition, the use of self-speech and breathing exercises helps the individual to cope with the difficulties and obstacles that accompany an attempt to change behavior to reach the point where behavioral adoption will now be a pleasant experience of life. Increasing the satisfaction and enjoyment that one receives, increases in motivation and ultimately leads to the maintenance of behavior and in the long run.

Purpose of the study

The present study intended to examine the acute effect of a moderate intensity exercise session combined with self-regulation strategies on smoking delay. Exercise has been recommended as an aid for smoking cessation. Many smoking cessation intervention programs incorporate physical activity as a coping strategy, in order to assist smokers to overcome withdrawal symptoms and smoking cravings, or even quit smoking (Marcus et al., 1999; 2003; Taylor & Katomeri, 2007; Taylor, Ussher, & Faulkner, 2007). Additionally, cognitive strategies, counselling and psychological techniques have been applied in some smoking cessation programs. Cognitive distraction could work as a strategy for reducing anxiety and stress (Morgan, 1997). Moreover, self-regulation strategies during exercise have proved useful for extending smoking delay (Hatzigeorgiadis et al., 2016). Considering the above evidence, this study aims to extend the literature on the acute effects of exercise through the investigation of smoking delay self-regulation strategies following exercise on smoking delay.

Method

Participants

Participants, recruited through public advertisement, signed consent forms regarding participation requirements and withdrawal rights. Participants were 40 adults (12 males and 28 females), with a mean age of 42 (±10.93), a mean weight 77.5 (± 15.70) kg; and mean height 1.68 (±0.80) meters. Participants were physically inactive (as assessed by the International Physical Activity Questionnaire—short form—IPAQ, www.ipaq.ki.se), adult smokers, who reported smoking on average 22.00 (± 7.55) cigarettes per day and 18.63 (± 10.1) cigarettes for the previous day. The mean score on the Fagerström test for nicotine dependence (Heatherton, Kozlwski, Frecker, & Fagerstrom 1991) was 4.27 (± 1.84).

Procedure

Ethical approval for the current study was granted by the University of Thessaly Ethics Review Committee. Participants were randomly assigned into two groups: exercise (E-group, control) and exercise plus self-regulation (E-SR group, experimental). A repeated measures design was adopted, including control and experimental conditions applied with a weekly interval. Upon recruitment, participants were informed that they should attend two morning sessions, that would last approximately two hours each, a week apart from each other, and they were told that for both occasions they would have to abstain from smoking overnight.

Baseline Condition

Upon arrival for the baseline condition, participants were asked to wear a polar strap (Sports Tester PE 3000, Polar Electro, Kempele, Finland) and rest in a supine position for 5

minutes. Resting heart rate was recorded using the polar watch and the 55th% of heart rate reserve was estimated using the Carvonen formula (REF). Subsequently, anthropometric measures were obtained, height and weight, and exhale CO levels were measured (PICO Smokerlyser, Bedfont, Rochester, UK). Then participants had to complete a questionnaire assessing (a) exercise (IPAQ), (b) smoking behavior (cigarettes per day and smoking dependency), and (c) smoking urge, through two items from the Questionnaire of Smoking Urge - brief (QSU-brief; Cox et al., 2001), on a 7-point scale ranging from 1 (none) to 7 (too much).

For the baseline assessment, participants of both groups participants were asked to watch a neutral themed video for 20 minutes, during which they were not allowed to smoke. Heart rate was recorded every five minutes. After the completion of the 20 minutes, participants were informed that they would have to remain at the lab for another 60 minutes, during which they could continue watching the video, however they were allowed to smoke whenever they felt like. At that time, they were offered water and orange juice. During these 60 minutes, the time until lighting the first cigarette was recorded.

Experimental condition

Upon arrival for the experimental condition participants were asked to wear the polar strap. As in the baseline condition, exhale CO levels were measured and smoking urge was assessed. Subsequently, participants were asked to exercise on a cycle ergometer (Monark874E, Sweden) for 20 min. During cycling the experimenter was monitoring participants' heart rate, aiming at maintaining heart rate at 55±5% of heart rate reserve. Accordingly, the experimenter instructed participants to increase or decrease rotations per minute, so that they remain in the designated heart rate reserve range. During the 20 minutes, heart rate and power output (Watt)

were recorded every five minutes. In addition, participants' perceived exertion (6-20 Borg scale; Borg, 1982) was assessed every 5 minutes. During cycling participant could watch a neutral themed video. Upon completion of the 20 minutes, participants were informed that they would have to remain at the lab for another 60 minutes, during which they could continue watching the video, however they were allowed to smoke whenever they felt like. At that time, they were offered water and orange juice. During these 60 minutes, the time until lighting the first cigarette was recorded.

At that time, participants of the exercise and self-regulation group were introduced to the use of self-regulation strategies, which they could use if they wanted to. In particular, (a) regarding goal-setting, participants were given a form where they could complete after how much time they would smoke their first cigarette on a scale from 5min to 60 min with 5min intervals; regarding self-talk, they were provided instruction about self-talk cues they could use to prolong the delay and achieve their goal (e.g. "I set a goal, not to smoke for the next 5, 10 , 15….60 minutes"); (c) regarding breathing, they were provided instructions on how to breath so that they relax; (d) finally they were instructed to take some sips of water slowly, or take a brief walk outside the lab when they felt like smoking. Upon completion of the 60 minutes, participants were asked to complete a questionnaire assessing on a 5-point scale (1 = not at all, 5 = very much) which of the self-regulation strategies they used, and to evaluate on a 5- point scale (1= not at all, to 5 = very much) how useful they thought these strategies were. Finally, they were thanked for their participation.

Results

Control Measures

T-test were calculated to test for differences in personal characteristics and measures. The analyses showed no differences in any of the variables. In particular, for age, $t(38) = 1.22$, $p = .23$; for BMI, $t(38) = 0.46$, $p=.64$; for average cigarette per day, $t(38) = - 0.81$, $p = .42$; for smoking dependence, $t(38) = - 0.41$, $p= .69$; for heart rate rest, $t(38) = 1.25$, $p = .22$; for heart rate reserve, $t(38) = -0.84$, $p = .41$. The mean scores for personal characteristics and measures are presented in Table 1.

Table 1. Mean scores for personal characteristics.

	Exercise group	Exercise SR group
Age	44.10 ± 11.02	39.90 ± 10.71
BMI	27.84 ± 5.64	27.09 ± 4.40
HR rest	67.35 ± 6.79	64.50 ± 7.64
HR Reserve	126.52 ± 6.62	128.57 ± 8.65
Cigarettes	20.77 ± 9.01	22.92 ± 7.55
Smoking Dependency	6.05 ± 1.79	6.30 ± 2.07

Analyses of Repeated Measures were calculated to test for differences in control measures at (CO, smoking urge) baseline as a function of condition (control, exercise) and group (plain exercise, exercise SR). Regarding CO baseline the analysis showed a non-significant

condition by group interaction, F(1, 38) = 0.69, p = .41. Regarding smoking urge at baseline the analysis showed a non-significant condition by group interaction, F(1, 38) = 0.37, p = .37. The mean scores for the control measures at baseline are presented in Table 2.

Table 2. Mean scores for control measures at baseline for the two groups.

	Control condition		Exercise Condition	
	E group	ESR Group	E group	ESR group
CO	10.45±3.60	10.45±3.73	10.30±3.700	9.84 ± 3.62
Smoking urge	5.05 ± 1.74	5.22 ± 1.11	5.25 ± 1.24	4.87 ± 1.76

Analyses of Repeated Measures were calculated to test for differences in control measures at (HR at control condition, HR at exercise condition, and RPE and exercise condition) as a function of time (four 5min intervals) and group (plain exercise, exercise SR). Regarding HR at the control condition the analysis showed a non-significant time by group interaction, F(3,36) = 0.75, p = .53. Regarding HR at the exercise condition the analysis showed a non-significant time by group interaction, F(3,36) = 1.19, p = .33. Regarding RPM at the exercise condition, the analysis showed a non-significant time by group interaction, F(3,36) = 0.13, p = .99. Regarding RPE at the exercise condition the analysis showed a non-significant time by group interaction, F(3,36) = 20.51, p = .68. The mean scores for the control measures across time are presented in Table 3.

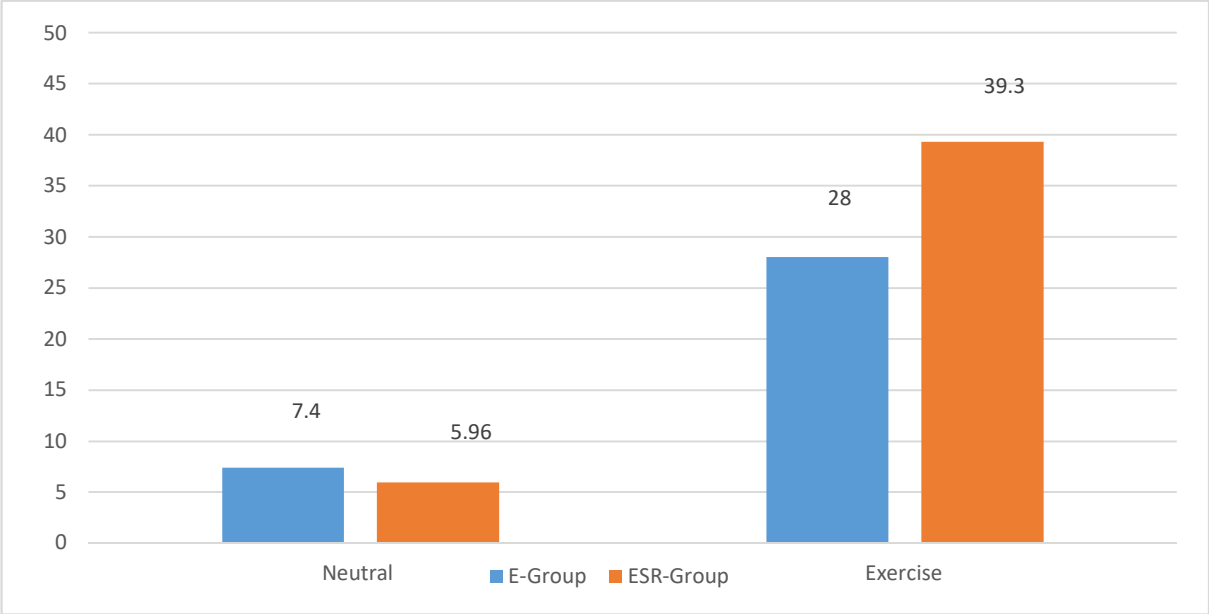
Table 3. Mean scores for control measures during exercise.

	Exercise group				Exercise SR group			
	5 min	10 min	15min	20min	5 min	10min	15min	20min
HR at baseline condition	74.50 ±20.79	75.65 ±9.56	75.20 ±8.55	76.15 ± 8.77	76.75 ± 8.54	75.35 ±10.18	74.10 ±11.49	74.10 ±9.84
HR at exercise condition	115 ±12.09	126.75 ±10.59	132.05 ±12.00	132.80 ±8.69	120.75 ±14.52	128.75 ±11.72	135.30 ±10.74	133.50 ±14.72
RPE at exercise condition	11.30 ±2.63	13.25 ±2.40	14.85 ±2.83	15.20 ±2.01	11.70 ±2.00	13.95 ±1.82	14.90 ±2.12	15.15 ±2.90

Hypothesis Testing

Two-way Analysis of Variance with one repeated factor (condition: control, exercise) and one independent factor (group: exercise, exercise SR) was calculated to test for differences in smoking delay as a function of condition and group. The analysis showed a significant condition and group interaction, $F(1,38) = 5.66$, $p < .05$. Examination of the pairwise comparisons showed that (a) smoking delay increased significantly for both the exercise and the exercise SR groups ($p < .01$), and (b) while there were no significant differences in smoking delay for the baseline condition ($p = .61$), for the exercise condition the delay for the exercise SR group was longer than the delay of the plain exercise group ($p < .05$). Smoking delay for the two groups across the two conditions is presented in Figure 1.

Figure 1. Smoking delay per group condition



Use and help of psychological strategies

Participants reported goal setting as the most helpful strategy (mean 3.70 ± 1.22), followed by drinking water (mean 3.66 ±0.97; whereas walking, breathing and self-talk were perceived as less valuable (for walking mean 2.61 ± 2.10 for breathing, mean 2.60 ± 2.11; for self- talk, mean 2.43 ± 1.74).

Discussion

The negative relationship between smoking and exercise, as described in the literature (Ussher, 2005), has led researchers to investigate smoking cessation interventions as a potential treatment for reducing or quit smoking. However, the results still remain inconsistent (Theodorakis, 2010; Ussher et al., 2012). Physical activity and self-regulatory strategies have been widely used as a means of changing behavior in different environments, and seem to be effective. Our findings confirm previous finding suggesting that exercise significantly increases smoking delay; in addition, suggest that self-regulation strategies such as goal setting, self-talk and breathing, can further increase this effect on smoking delay. Results are in line with previous research (Hatzigeorgiadis et al., 2016). Specifically, the current study showed that 20 minutes of moderate intensity exercise delayed smoking 20min compared to baseline, which is similar to the effect identified by Hatzigeorgiadis et al (2016). In addition, the supplementary use of self-regulation strategies further increased the delay by approximately 25%, compared to plain exercise condition. These results were supported through statistically significant differences between the exercise and the exercise plus self-regulation groups during the experimental condition.

Literature review has suggested that smoking delay is depends on the intensity and duration of exercise. According to Taylor, Katomeri and Ussher, (2005), 20 minutes of moderate exercise delayed smoking for at least 20 minutes. Thus, we hypothesized that 20 minutes of moderate cycling, with the complementary use of self- regulation strategies, could lead to a further smoking delay. Cycling is a form of exercise which has been extensively used along with walking on interventions and laboratory researches, which were investigating smoking behaviors (Ussher et al., 2003). Goal-setting, self-talk and breathing were offered as alternative self-

regulation methods that have been successfully implemented in studies with physical activity interventions. In addition, participants were also advised to take small zips of water or walk when they felt urge to smoke. Among these strategies goal-setting and drinking water were rated as the most useful strategies, followed by walking, breathing and self-talk. Self-regulation could be the key to understanding addiction, as addictive behaviors cannot be internally regulated (West, 2006b). Thus, Cross and Marcus (1991), recommended the use of self-regulation strategies as beneficial means that lead to a change for a desirable behaviour.

Considering that the effects of exercise on smoking urge and smoking delay have been well documented in the literature, the contribution of this research in the relevant literature is the beneficial added effects of self-regulation strategies on smoking delay. Adding self-regulation strategies enhanced smoking delay by a statistically significant and practically important degree. The use of self- regulation strategies, may have increased participants' motivation, self- control, and self-confidence, and helped them take additional steps towards the goal, which was actually set by them. Such effects on self-efficacy have been previously reported in the literature (Zimmerman, 2000; McCrory, Cobley & Marchant, 2013). Further studies are required to strengthen our confidence in these findings, and to look at additional self-regulation techniques. Nevertheless, the present research strengthens our understanding and provides valuable evidence that these strategies should be carefully considered for the development of interventions based on quitting smoking. In fact, in longitudinal exercise interventions self-regulation strategies can be more elaborately practiced and mastered by participants; training self-regulation strategies will most likely further enhance their effectiveness. The development and evaluation of such interventions is warranted to confirm such postulations.

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